Accelerating Your Application I/O on HPC Systems

Poster Presentation

August 18, 2020

Cameron Stanavige

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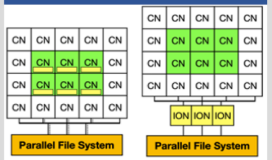
Sarp Oral (Co-PI), Feiyi Wang, Hyogi Sim, Mike Brim, Swen Boehm (**Oak Ridge National Laboratory**)
Craig Steffen, Celso Mendes (**National Center for Supercomputing Applications**)

Abstract

As the HPC community pushes towards exascale, HPC clusters are becoming increasingly complex. Part of this complexity is introduced by the addition of new storage tiers, such as burst buffers. Each tier may have different performance characteristics and may be subject to different policies regarding availability or allocation. A number of tools are under active development to improve file set management, both between tiers and within a single tier.

Types of Burst Buffers



Node Local	Machine Global
LLNL Sierra	LANL Trinity, NERSC Cori
IBM BB	Cray Datawarp
NVMe over Fabrics	IO-Nodes
Compute Node Namespace	Global Namespace
Single Allocation	Multiple Allocations

MPIFileUtils — https://github.com/HPC/mpifileutils

Suite of MPI-based file utilities to manage large datasets, including large directory trees and large files.

Tool	Speedup
dcp	51×
dcmp	60×
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Speedup compared to regular Unix utility, using 256 MPI processes, operating on 1 million files.

Workflows

Data Migration

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dwalk -> dcp -> dcmp --lite -> dsync
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LC Policy Implementation

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mpirun -np 128 drm --aggressive ./_AutoDelete
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Available Tools
- dbcast
- dbz2
- dchmod
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Help wanted!
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Collaboration
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SCR: Scalable Checkpoint Restart Library — https://github.com/LLNL/SCR

Allows MPI applications to utilize hierarchical storage for high I/O bandwidth.

Library

- Simple integration by marking application I/O phases
- Support for file-per-node I/O patterns
- Automatic management of checkpoint vs. output files

Usage

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- Reliability through cross-failure domain redundancy
- Automatic hang-detection and restart
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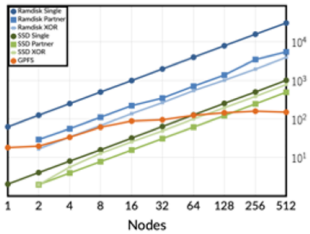
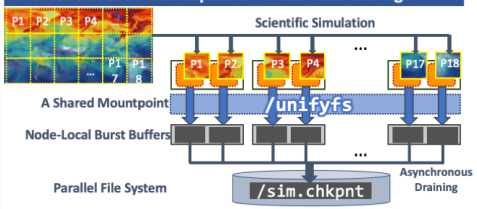
SCR Scaling Performance (GB/s)



UnifyFS — https://github.com/LLNL/UnifyFS

Creates a Shared Namespace on Node-Local Storage



Using UnifyFS in a Job is Easy

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#!/bin/bash -l

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UnifyFS: Project Description and Scope

- User-level file system
- Highly-specialized for shared file access on HPC systems with distributed, node-local burst buffers
- Integration with resource managers to instantiate UnifyFS in user jobs

Will Support Common HPC I/O Use Cases

- Disjointed write and read phases, ideal for most checkpoint workload
- Scientific applications generating periodic output data
- Ensemble applications sharing data through files
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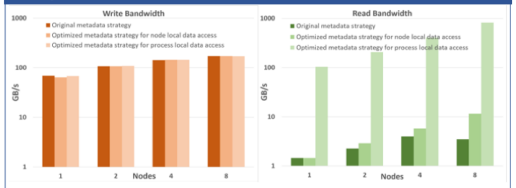

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- Recent optimizations** can speed up reads by up to 236x over our baseline performance

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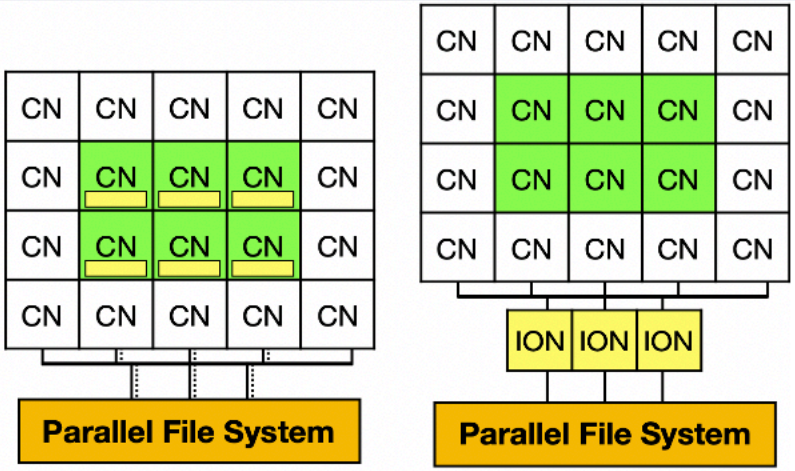

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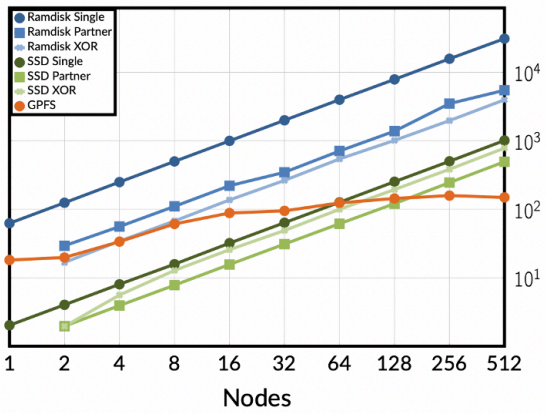

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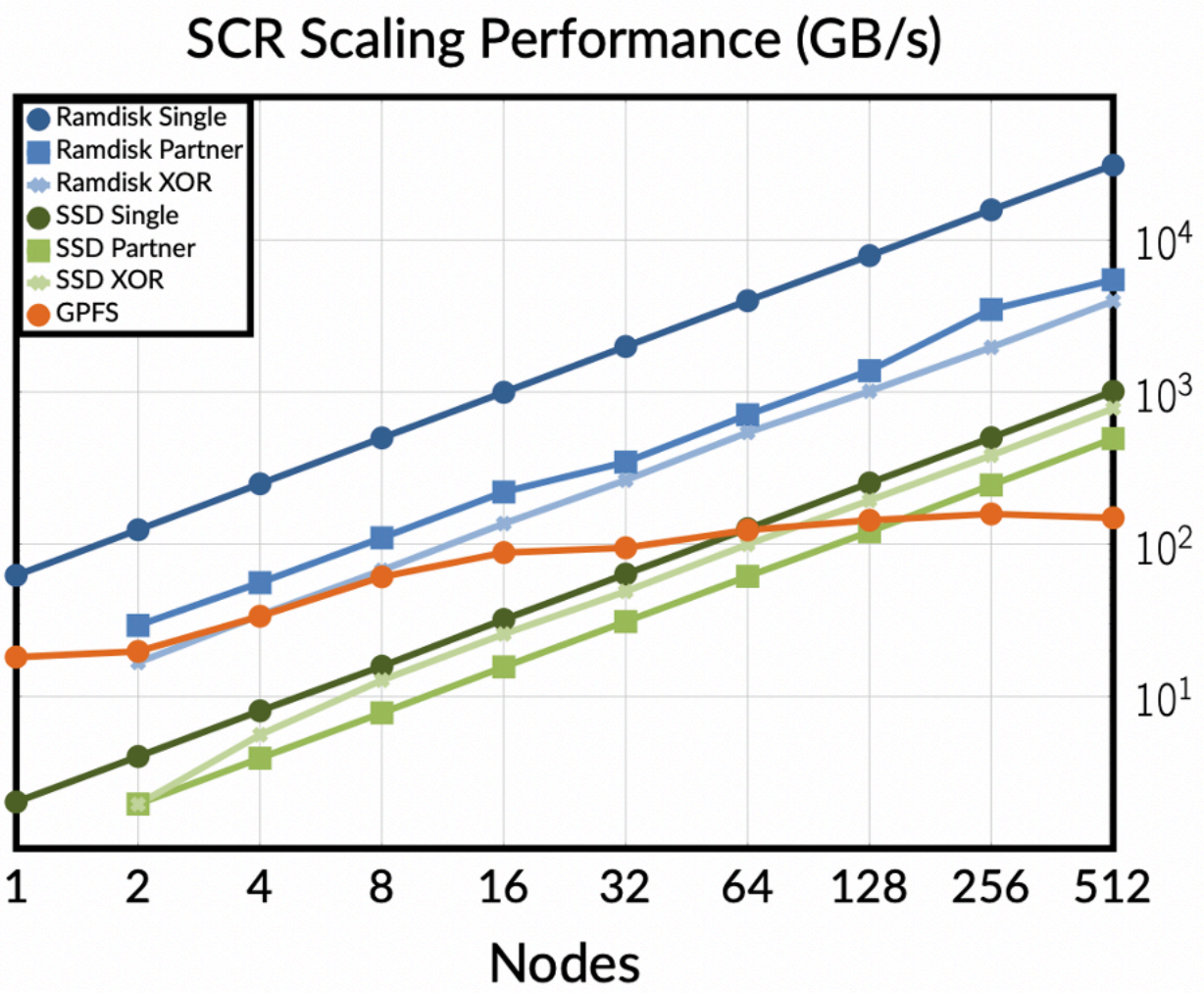
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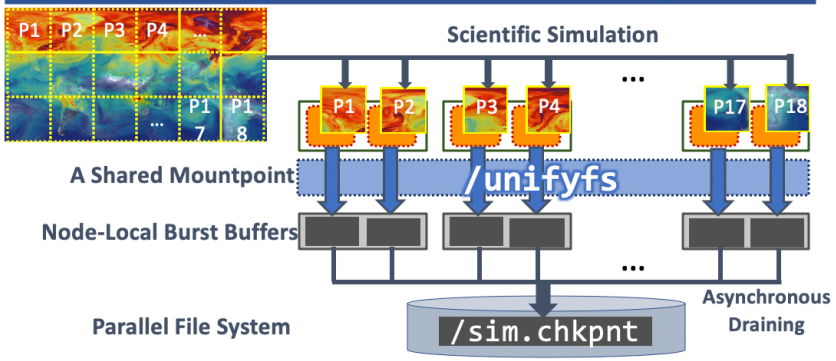

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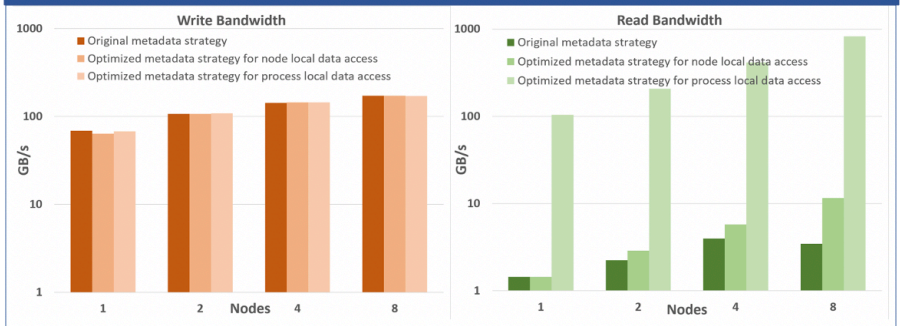

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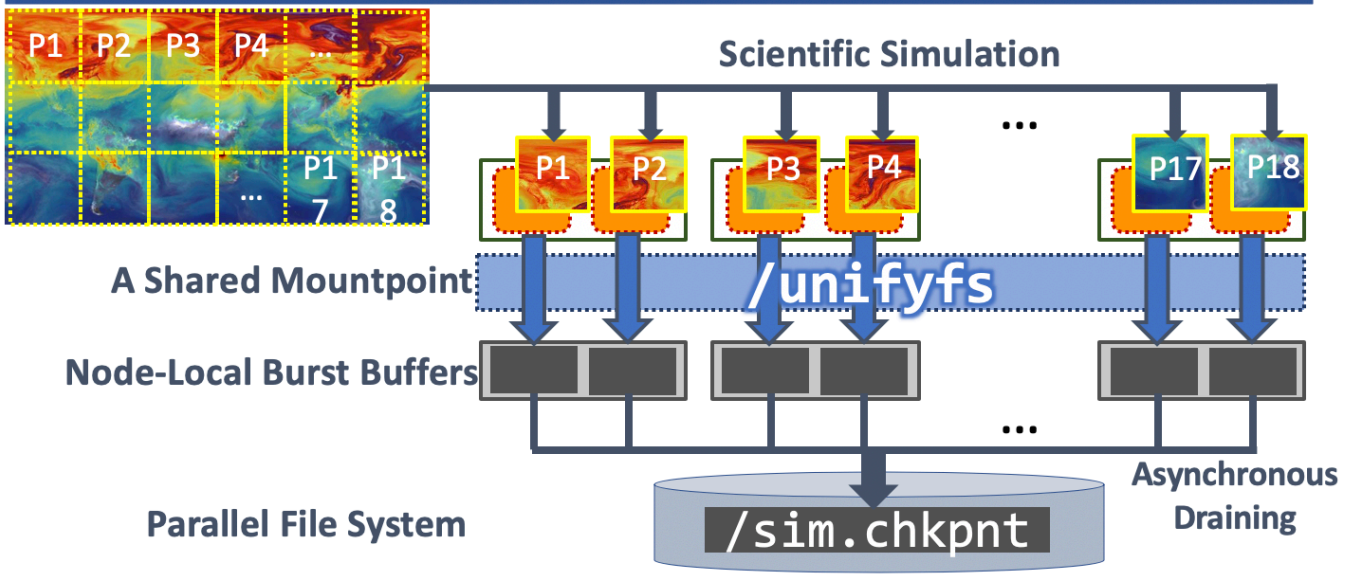

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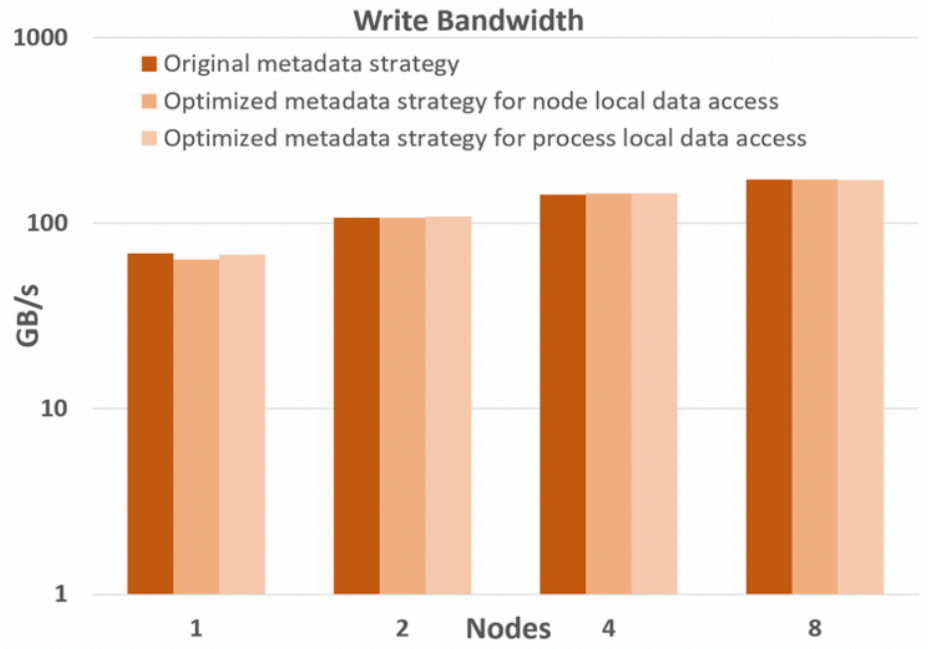

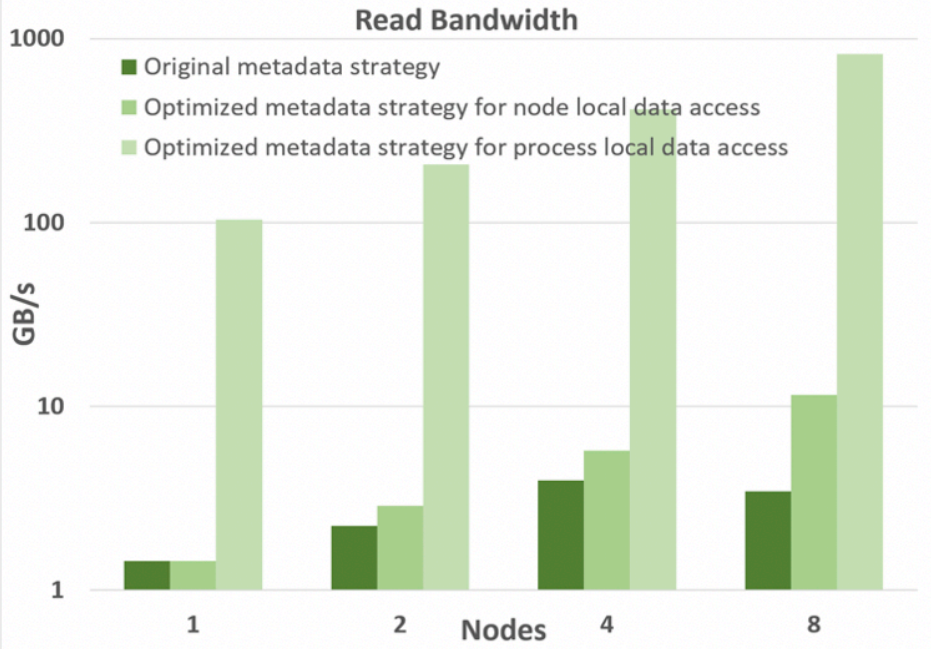

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